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Development And Evaluation of Nutribar Using Functional Ingredients

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Abstract

Food is typically made from plants and animals and contains all the vital vitamins, minerals, fats, and proteins that every human needs to keep well and live a longer life. A food is made functional in several ways. Snack bars are ready-to-eat foods which are versatile, portable and convenient. The primary focus of this study was on exploring utilization of date seeds, a highly rated waste product in Indian population despite its dense nutrient content and functional properties to create a nutrient rich snack to create a nutrient-rich snack that could serve as a replacement for less nutritious options. The development of the Nutribar was motivated by the goal of providing a snack that could contribute to daily nutritional requirements, offering essential nutrients such as energy, protein, vitamins, minerals, and fibre. Its preparation method included sun drying, baking/roasting, grinding into powders of date seeds, sweet potato and watermelon seeds. It was further mixed with ghee, jaggery and kept for setting in a Mold and the bars were stored in airtight containers. The 3 different variations of Nutribar were developed. To ensure its acceptability, a panel of 40 semi-trained panelist evaluated the 3 variations of Nutribar and assessed their sensory attributes, including appearance, texture, colour, aroma, taste, and overall acceptability, using a 9-point Hedonic scale. Average mean was statistically computed to select the best scored Nutribar in sensory acceptability and was sent for nutrient analysis. An attractive and suitable packaging and labelling was designed and developed for the Nutribar. The statistical analysis showed that there was a significant difference in texture and colour between the three variations but there wasn't a significant difference in appearance, taste, aroma, and overall acceptability even after when the proportion of date seeds and sweet potatoes was increased from 10g to 20g. This means that the

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Nutribar retained its taste even after adding more of nutritious ingredients highlighting promising presence of nutrients like energy, protein and antioxidant. Through sensory evaluation, nutritional analysis, and shelf-life testing, the Nutribar emerged as a promising ready-to-eat snack, addressing both utilization of food waste and the demand for healthier snacking alternatives. Its balanced nutritional content positions it as a convenient and beneficial option for individuals of all age groups, promoting overall health and well-being with its antioxidant-rich properties.

Keywords: Nutribar, Functional ingredients, Sensory evaluation, Shelf life, Date seed

Introduction

According to the Functional Food Center (FFC), a "functional food" is any natural or processed food that contains known or unknown biologically active compounds and that, when consumed in amounts that are specific, efficient, and safe, has a documented health benefit for the treatment, management, or prevention of chronic disease. [1]

The term "ready-to-eat" (RTE) refers to a class of food items that have been cleaned, cooked, and most often packaged before being made available for consumption. [2]

Nutribar is one of the ready-to-eat convenient snack bars occupying a larger space in the consumer market. It has been shown to be an effective source of nutrients and an easy way to substitute a meal in addition to satisfying hunger. Due to their important nutrients, they have good sensory and nutritional qualities.

High-waste ingredients are foods that are highly ignored but have functional benefits and nutritional value.

Date pits are regarded as a great and rich source of waste product as food ingredients that may be employed in food applications since they are high in nutritional fibre. According to the published study, Date seed Powder (DSP) can be utilized to make functional foods for human consumption. Additionally, the role of DSP in the preparation of various traditional medications for human health

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is increased. Patients with high blood pressure benefit when the ratio of Na to K is less than one. [3]

Watermelon seeds are often discarded and ignored, but they have high nutritional benefits and can be utilized in many ways. Watermelon is one of the most important crops, and its fruit pulp is used to make juices, fruit cocktails, and nectars, among other things, while "the rind" is used to make pectin, make pickles, feed cattle, and so on. Watermelon seeds are also said to be an excellent source of protein. Proteins from watermelon seeds have been extracted in a number of investigations. Watermelon seed proteins include globulin, glutelin, albumin, and prolamin.[4]

Pumpkin seeds are a good source of minor minerals such zinc, manganese, iron, calcium, sodium, and copper as well as magnesium, potassium, and phosphorus. Some of these bioactive substances and minerals have the capacity to provide physiological advantages, promote wellbeing, and lower the risk of non-communicable diseases like tumours, microbial infections, hyperglycaemia, and diabetes, oxidative stress-associated complications, prostate disorders, and urinary bladder complications. These substances and minerals also act simultaneously at various or identical target sites. The wound-healing, hair-growth-stimulating, anthelmintic, antioxidant, and chemoprotective qualities of pumpkin seed extract (PSE) are some of its other medicinal benefits. [5]

Sweet potato is large thick sweet and nutritious tuberous root. It has several health benefits as it is nutrient rich. Sweet potatoes nutritional worth has been rediscovered as a functional food with high concentrations of a number of phytochemicals that may have a number of health benefits.[6]

Snack bars are useful for plenty of people due to their adaptability, including athletes, those on diets, individuals with nutritional problems, and people who eat irregular meals. Due to advance technology and health-conscious society, there is an interest in making new types of snack bars with functional components. The presence study aims at developing a Nutribar made using ingredients having functional properties and high waste. The developed Nutribar may be considered as one convenient and easy-to-store product suitable for all age group.

SCOPE OF THE STUDY:

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High waste index ingredients can be reduced by proper guidance and education. The knowledge of date seeds consumption as food is highly ignorant among the Indian population as they are generally discarded. According to studies, date seeds have a high waste index despite its potential functional benefits. Other ingredients like sweet potato, pumpkin seeds, watermelon seeds are among the sources that are found to have functional properties. The present study focuses on developing a Nutribar using functional ingredients like date seeds, sweet potato, watermelon seeds is assumed to be a nutrient rich snack that may provide ¼ th of the daily snack requirement rich in energy, protein, essential vitamins and minerals and fibre for all age groups as it can be easily prepared at home. Since the Nutribar was made using functional ingredients it can be suggested to maintain health and wellbeing and easy recovery due to its antioxidant properties.

OBJECTIVE:

1. To standardize a Nutribar using functional ingredients with a high waste index.
2. To evaluate sensory acceptability of different Nutribar variations.
3. To analyse the nutrient composition and shelf life of the best-rated Nutribar.
4. To estimate the cost of production for the selected Nutribar.

REVIEW OF LITERATURE

The literature that is relevant to the study entitled development and evaluation of Nutribar using functional ingredients has been analysed from various research studies and reviews from various journals. It has been categorized and discussed under the following topics.

a. Role of functional foods for health

b. Nutritional benefits and functional properties of high waste index foods.

c. Management of food byproducts into value added products

a. ROLE OF FUNCTIONAL FOODS FOR HEALTH

This review talks about how functional foods and their bioactive compounds might help with weight management and obesity prevention. The study found that certain foods like coffee, green tea, berries, nuts, olive oil, pomegranate, avocado, and ginger, as well as specific compounds found in them, could play a role in managing weight and preventing obesity. These foods may impact

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factors like appetite, fat absorption, and calorie burning. It can be concluded that Functional foods, as part of a balanced diet, could be useful in weight management and reduce obesity. [7]

The article suggests that the concept of "functional foods" revolves around the idea that certain foods and nutrients can offer health benefits and reduce the risk of disease. Fruits, vegetables, and culinary herbs have significant evidence for their potential to promote health. These foods contain bioactive compounds like phytochemicals, polyphenols, vitamins, minerals, and organic acids, which contribute to their antioxidant and anti-inflammatory properties. Hence functional foods, bioactive compounds play a positive impact on human health by preventing cardiovascular disease, neurodegenerative disorders, and cancer. [8]

b. NUTRITIONAL BENEFITS AND FUNCTIONAL PROPERTIES OF HIGH WASTE INDEX FOODS.

This research by article aimed to make bakery products healthier and reduce waste by using date seed powder (DSP). DSP contains nutrients like minerals, amino acids, fatty acids and antioxidants, which are good for health. DSP was added to toast bread and crackers, replacing some of the wheat flour. Panelist tasted these products, and most of them liked the taste. Therefore, it is possible to make bakery items healthier by adding DSP. [9]

Pumpkin seeds are small but packed with healthy nutrients like amino acids, fatty acids, and antioxidants. This review looks at the potential benefits of using pumpkin seeds in food. These seeds help in fighting parasites, managing diabetes, boosting mood, and protecting against diseases like cancer. [10]

Some of the researchers tried to understand watermelon seeds characteristics and how they can be used. These seeds have a tough outer shell that needs to be removed before using them. They are oval and light cream in colour. The researchers found that these seeds can absorb a lot of water and don't turn into gel easily. When they analysed the seeds composition, they found that they have low moisture, low ash, high fat, high protein, and are quite energy-rich. They also tried using powdered watermelon seeds in recipes at different amounts, and people generally liked the products they made. Overall, it can be concluded that watermelon seeds are rich in protein, fat, and other nutrients, and they can be added to dishes like vegetable gravy. [11]

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c. MANAGEMENT OF FOOD BY-PRODUCTS INTO VALUE ADDED PRODUCT

Watermelon is a really healthy fruit, originating from Africa. Watermelon rind the part we usually throw away, the white rind, is good for the health as it has fibre that helps your digestion and can slow down sugar absorption in the body. The rind is also packed with antioxidants, vitamins, and other good nutrients. It was concluded that watermelon rind can be used in different foods as a value-added product. [12]

The world's population is growing, and so is the demand for food. However, we face challenges like resource scarcity and lots of food waste, especially parts of fruits and vegetables that are not eaten. These unused parts, like peels, seeds, and more, can harm the environment. These by-products can be used to make new and healthy foods. This helps with sustainable eating, and some of these by-products are nutritious and can be used in the food industry. The review article also explains ways to turn these by-products into useful foods, nutrition content, processing method and different ways of combining in food preparation. Using these by- products it can provide nutrients by using them in baked goods and dairy products and thus help us reduce food shortage. [13]

METHODOLOGY

The study titled *"Development and Evaluation of Nutribar Using Functional Ingredients"* was conducted at the Post Graduate Department of Nutrition and Dietetics, Bishop Cotton Women's Christian College, Bengaluru. Product development and sensory evaluation were carried out in the Nutrition and Dietetics laboratory.

This experimental study focused on transforming high waste-index ingredients into a value-added functional snack. Date seeds, often discarded despite their rich nutrient and functional properties were utilized along with sweet potato powder, watermelon seed powder, and pumpkin seeds to enhance nutritional quality. The Nutribar was developed as a healthier alternative to low-nutrient snacks. Sensory evaluation was performed using organoleptic parameters including appearance, colour, flavour, texture, and overall acceptability.

Raw Materials

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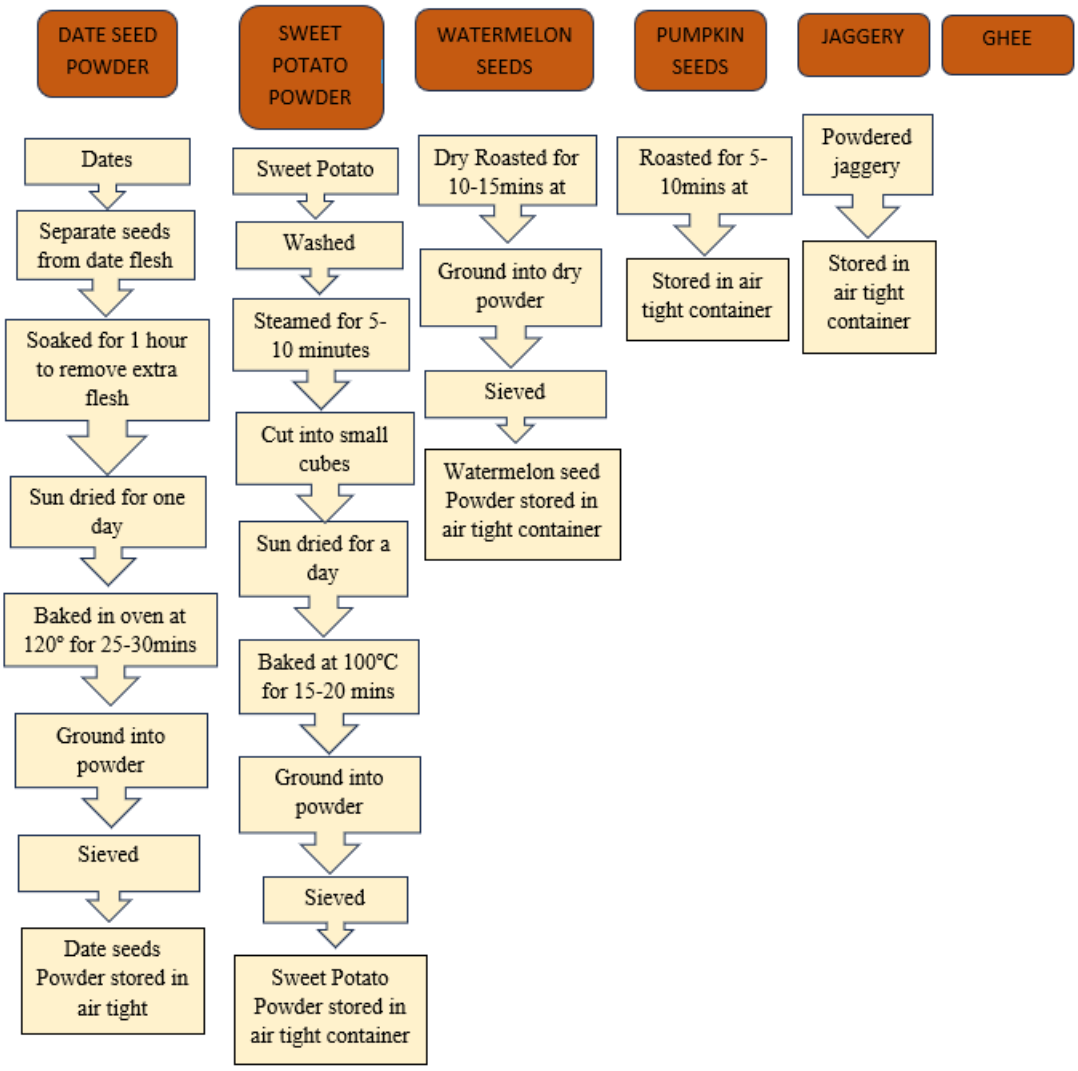
The ingredients used were date seeds, sweet potato, watermelon seeds, pumpkin seeds, jaggery, and ghee. All ingredients were of good quality and stored in airtight containers. No artificial Flavors, colours, or preservatives were added.

Equipment

Standard kitchen equipment including a weighing machine, measuring spoons, gas stove, heavy-bottom pan, ladle, and mould tray were used. All equipment was thoroughly cleaned prior to preparation.

FLOW CHART ON PRE-PREPARATION OF NUTRIBAR INGREDIENTS



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PREPARATION OF NUTRIBAR IN THREE DIFFERENT VARIAITON:

Three variations of Nutribar have been developed using different proportions of selected ingredients.

Table 1: Percentage composition of the ingredients used for developing Nutribar:

INGREDIENTS	VARIATION 1	VARIATION 2	VARIATION 3
Date seeds powder	35%	39%	41%
Sweet potato powder	35%	39%	41%
Watermelon seeds powder	17%	13%	10%
Pumpkin seeds	10%	7%	6%
Jaggery	89%	65%	52%
Ghee	0.89%	1.31%	10%

METHOD OF PREPARATION

In a bowl, combine all the dehydrated powders, including date seed powder, sweet potato powder, and watermelon seed powder. Meanwhile, heat a heavy-bottomed pan on a low flame, add ghee, and allow it to melt before adding jaggery powder. Heat the mixture until it reaches the soft crack stage (132ºC–143ºC). To check this stage, drizzle a drop of jaggery syrup into ice-cold water; it should form threads before cracking, producing a crackling sound. Once the soft crack stage is achieved, add the mixed dehydrated powders to the syrup and stir well using a ladle until thoroughly combined. Transfer the mixture into a mould tray, garnish with pumpkin seeds, and allow it to set for 1–2 hours. Finally, store the prepared Nutribar in an airtight container. Note that all three variations of Nutribar were prepared following the same method.

SENSORY EVALUATION OF STANDARDIZED NUTRIBAR

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Sensory evaluation was conducted using 9-point Hedonic scale to determine the acceptability of the developed Nutribar. Hedonic Scale is a scale that indicates the extent of respondents' overall liking or disliking for something, e.g. a product they tasted or a concept they viewed. the use of a rating scale in the assessment of liking or approval with or pleasure obtained from an object (e.g., brand, product, concept) being evaluated. [14]

Sensory evaluation of the developed Nutribar with different variations was conducted in 40 semi trained panelist who were randomly selected from the college campus.

The samples of 3 variation Nutribar were individually packed in a small transparent zip lock bag and presented in a coded manner. (C1, C2, C3) The panelist was allotted places to evaluate the product. On consolidating the evaluation card, the average mean of the overall acceptability of all the three variations were assessed to choose the best accepted Nutribar.

NUTRIENT ANALYSIS OF STANDARDIZED NUTRIBAR

Nutrient analysis of the best accepted Nutribar Sample was done in an FSSAI approved NABL accredited lab. The method used for the Estimation of nutrient analysis was based on AOAC method and FSSAI manual. The estimation of Energy content (SOP Method), Total Carbohydrates (Anthrone Method), Total Fat (Simple extraction method), Protein (Kjeldahl Method), Iron (Atomic Absorption Spectrophotometer), Fiber (Crude fiber content general method) and Antioxidant levels as Vitamin C (HPLC Method).

SHELF-LIFE STUDY OF STANDARD NUTRIBAR

Shelf life of a product refers to the duration of time during which a product is safe to consume by retaining its flavour, quality, nutritional value and effectiveness. [15] .Shelf study of the best scored Nutribar was studied using sensory shelf-life test and microbial test. For Sensory test- A sensory shelf-life test was conducted to confirm the duration using hedonic rating scale for which the product will maintain its original quality or characteristics.

For Microbial test - Total Plate Count and Total Yeast & Mold Count test was analyzed. Total yeast and mould count is a microbiological testing method used to determine the overall quantity of viable yeast and mould microorganisms present in a sample.[16]

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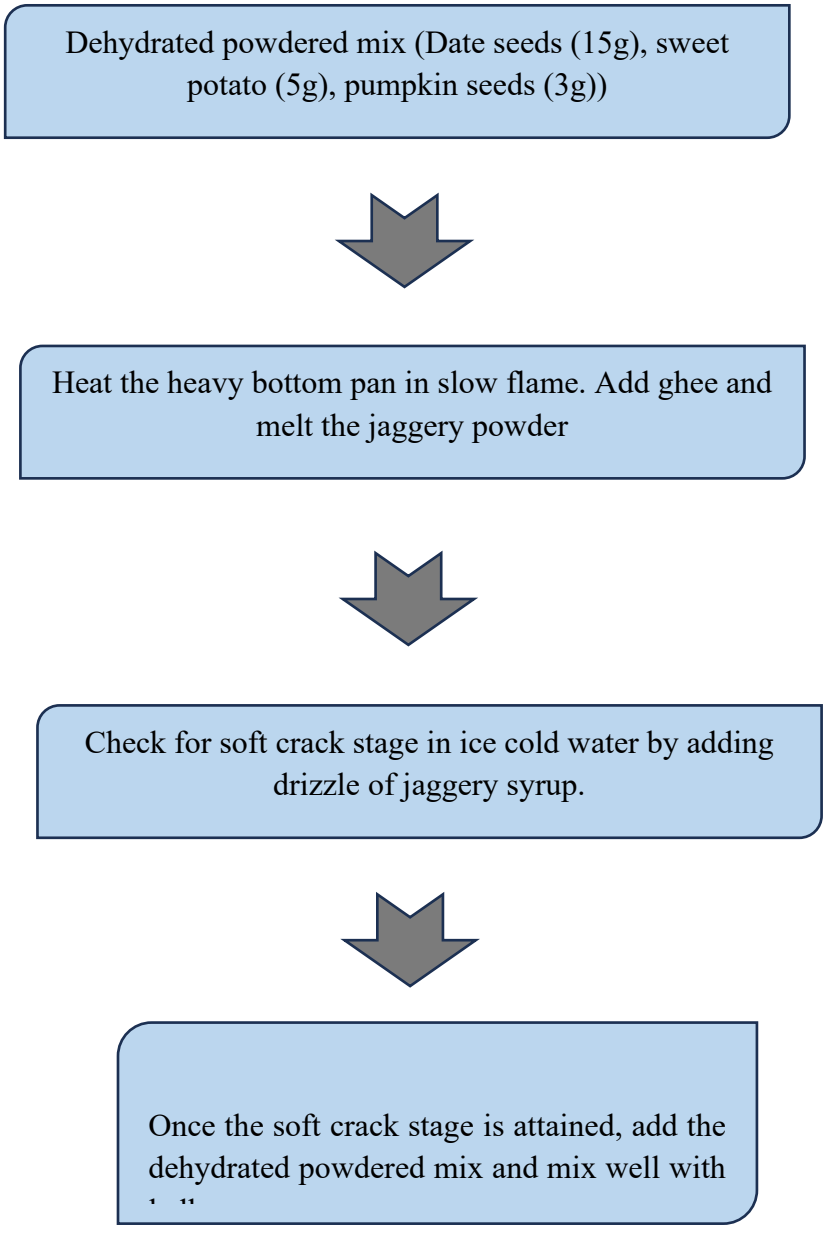
The Shelf life of the best scored Nutribar was carried out at room temperature for a period of 2 weeks. The Shelf life of the best scored Nutribar was carried out at room temperature for a period of 2 weeks to check for the presence of any visible spoilage.

STANDARDISATION OF BEST SCORED NUTRIBAR BASED ON SENSORY EVALUATION

(FINAL PRODUCT)



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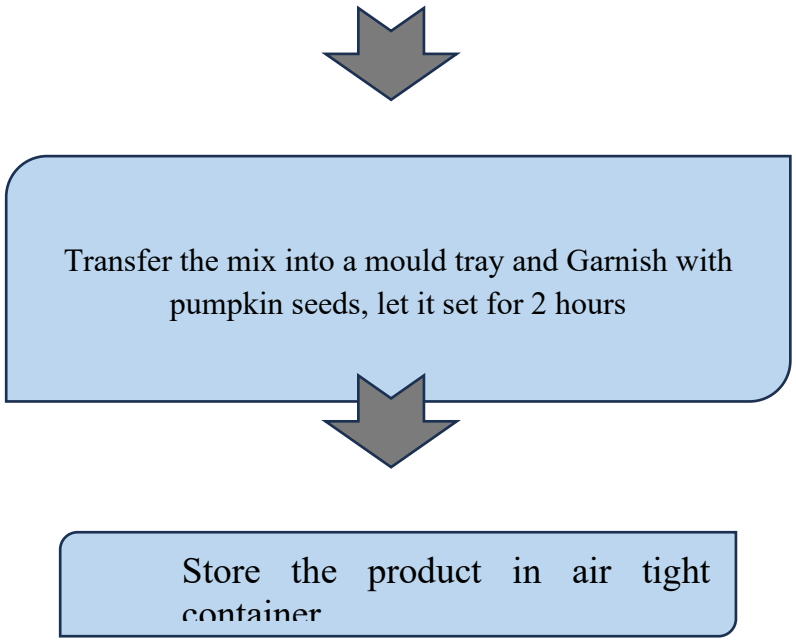

COSTING OF THE PRODUCT

Costing refers to the systematic allocation of expenses involved in product preparation. The standardized recipe, considering the overhead cost, labour cost, profit margin and packaging cost percentage which estimated selling price as ₹40 which is equal to the commercial Nutribar cost.

PACKAGING

Packaging is important since it helps with storage, use, and convenience while also protecting and promoting the product. An attractive and suitable packaging and labelling was designed and developed for the Nutribar. The packaging consists of Flexible Plastic Wrappers, which is lightweight, cost-effective, and offer good barrier properties to protect the bars from moisture and air. It also elongates the shelf life of the products. The label was designed using the Canva application. The label was designed in accordance with the FSSAI guidelines.

Label of Nutribar

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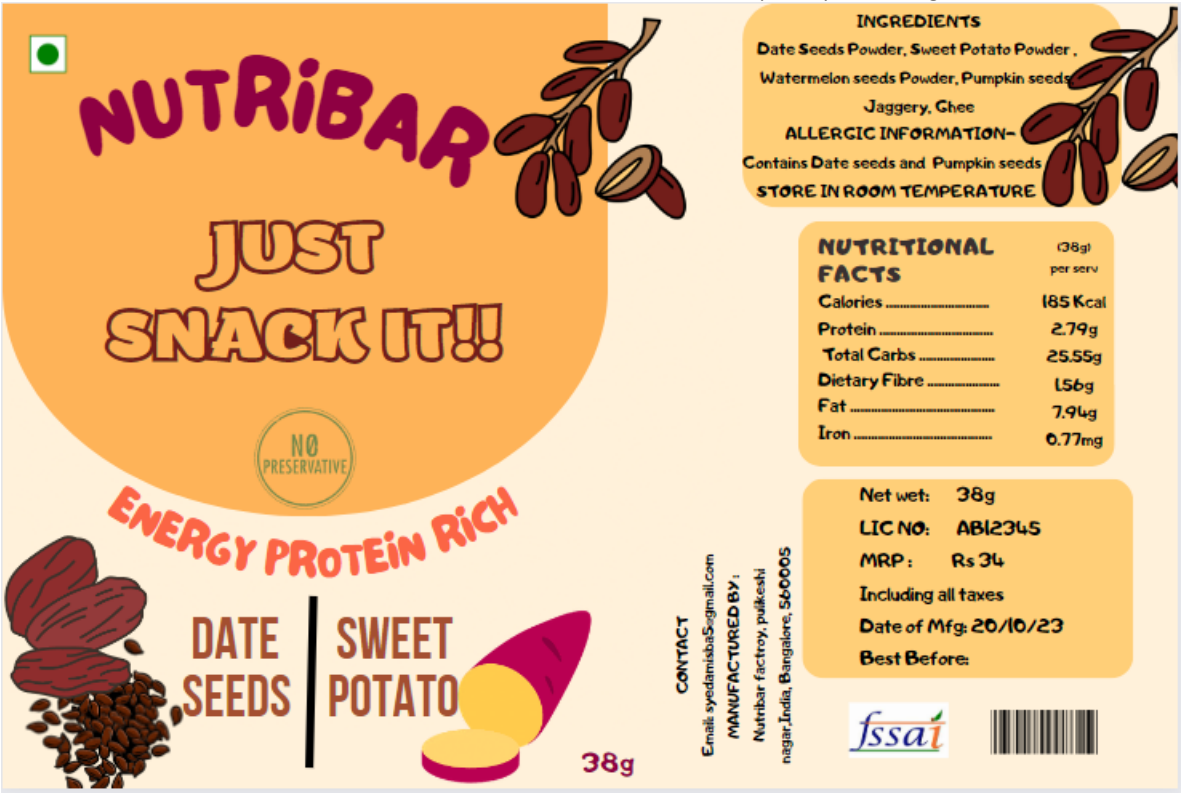

STATISTICAL ANALYSIS

Statistical analysis was done for all the variations. ANOVA is a statistical method that separates observed variance data into different components to use for additional tests. T- test is a statistical test that is used to compare the means of two groups. It is often used in hypothesis testing to determine whether a process or treatment actually has an effect on the population of interest, or whether two groups are different from one another. [17]

The sensory score was computed for statistical analysis. T- test was done to see the difference in each variation and ANOVA was done to check if each variation is statistically different.

RESULTS AND DISCUSSION

SENSORY EVALUATION OF STANDARDIZED NUTRIBAR

Sensory characteristics like appearance, colour, texture, taste, flavour, and overall acceptability were rated using a 9-point hedonic rating scale. From a scale of 9 to 1 the acceptance of Nutribar was determined to select the best scored Nutribar among the three variations.

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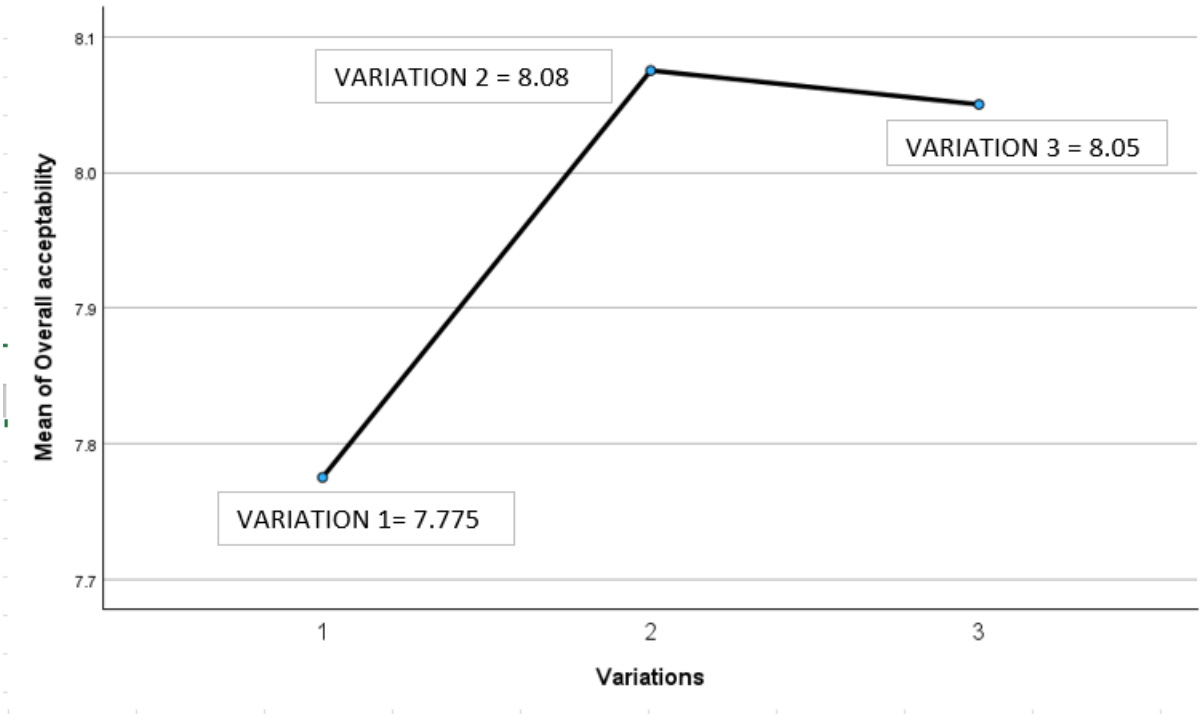
GRAPHICAL REPRESTATION OF OVERALL ACCEPTABILITY BETWEEN VARIATION 1, 2 AND 3



It is evident from the table that difference in average mean for overall acceptability among the three variations was only in decimal difference, on comparing variation 2 had a score of (8.08) proving that it was mostly liked by the panelist in terms of appearance , taste, texture, colour, aroma and overall acceptability when compared with variation 3 and 1. Assuring that three variations are acceptable in sensory and hence was accepted as the best scored Nutribar and was further proceeded for nutrient analysis.

STATISTICAL INTERPRETATION

The statistical analysis revealed that between Variation 1 and Variation 2, significant differences were observed only in texture (p=0.04) and colour (p=0.01), while no significant differences were noted in appearance, taste, aroma, or overall acceptability. Similarly, comparison between Variation 1 and Variation 3 showed significant differences in texture (p=0.01) and colour (p=0.03), with other attributes remaining comparable. No statistically significant differences were found between Variation 2 and Variation 3 for any sensory parameter, indicating similar acceptability.

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ANOVA results further confirmed a significant difference only in texture (p=0.0306), while other attributes including overall acceptability showed no significant variation among the three formulations. Post hoc test indicated that the significant difference in texture was specifically between Variation 1 and Variation 3. Overall, increasing the proportion of functional ingredients did not adversely affect appearance, taste, aroma, or overall acceptability of the developed Nutribar.

NUTRITIVE ANALYSIS OF THE BEST SCORED NUTRIBAR PER 100g

Table 2: Nutrient Analysis of the Nutribar

NUTRIENTS	ANALYSED VALUE PER 100g	ANALYSED RESULTS PER 38g
Energy	487Kcal	185kcal
Total Carbohydrates	67.26g	25.55g
Total Fat	20.9g	7.942g
Protein	7.35g	2.79g
Iron	2.04mg	0.77mg
Fibre	4.13g	1.56g
Antioxidants as Vitamin C	5.60mg	2.128mg

The best scored Nutribar with variation 2 formulation assessed for nutrient analysis revealed that the 100g of Nutribar provided the nutritional content of 487 Kcal of energy,67.26g of CHO, 20.9g of Total fat and 7.35g of protein,2.04mg of iron and 4.13g of fibre and antioxidant of 5.60mg of Vitamin C. The nutrient contribution per serving (38g) computed from 100g value is 185 Kcal of energy, 25.55g of carbohydrates, 7.942g of total fat, 2.79g of protein, 0.77mg of iron, 1.56g of fibre and 2.128mg of antioxidants.

The developed food product demonstrated that date seeds can be used to formulate food products like Nutribar along with other functional ingredients combination that can provide sufficient amount of energy and protein to the body with antioxidants. The prepared Nutribar can also be

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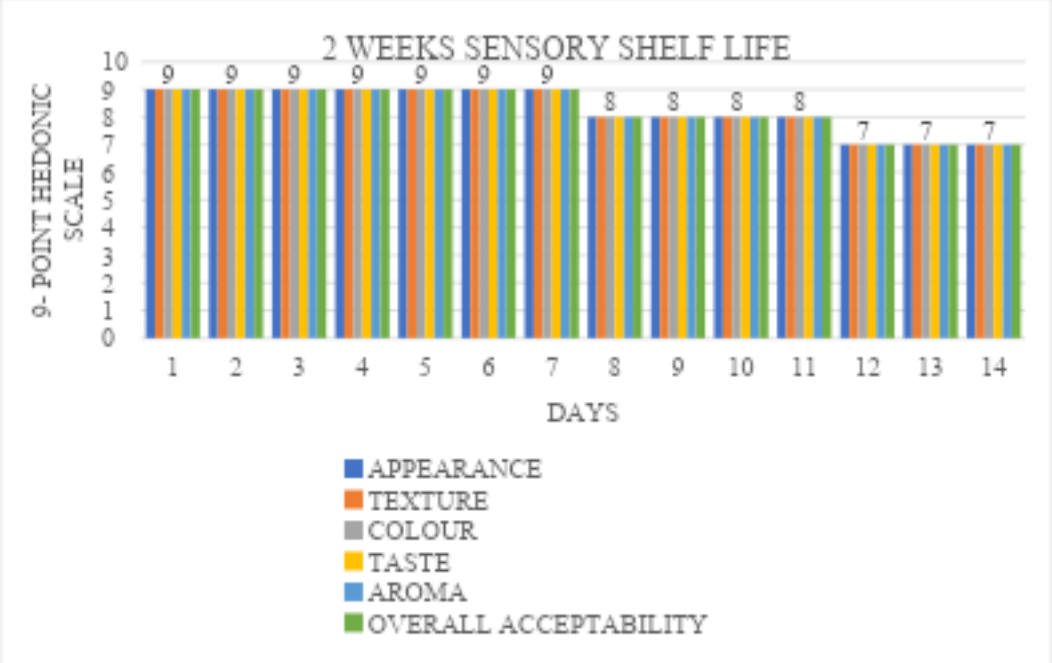
recommended as a substitute in place of less nutrient snack bar as the ingredients used in Nutribar preparation were chosen with an intention to provide enough energy and protein, fat, fibre and antioxidant like Vitamin C that can also be recommended as meal replacement bar for different age group people namely children and sports people that helps in energy contribution, muscle growth and antioxidants promoting overall wellbeing.

SHELF-LIFE STUDY

a. SENSORY SHELF-LIFE TEST

Sensory Shelf-life test was carried out at room temperature for a period of 2 weeks.



The above graph predicts the sensory shelf life of the product for a period of 2 weeks. The sensory test included the physical change in terms of sensory character appearance, texture, colour, taste, aroma, and overall acceptability. It can be observed that for the first seven days all the sensory attributes were scored 9 (Liked extremely). After a week the next 4 days the sensory attributes reduced to the score 8 (Like very much). The following three days the sensory attributes were reduced to score 7 (Like moderately) because of the high fat content there was a rancid taste. Overall, there was no visible signs of spoilage seen.

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b. MICROBIAL TEST

Table 3: Microbial test analyses

Test	Analyses Duration	Analyses Duration	LIMITS
	1st week	2nd week	
Total Plate Count /g	<10 cfu	625 cfu	Log 10^4 cfu
Total Yeast & Mold Count/g	<10 cfu	<10 cfu	Log10^2 cfu/g

Microbial analysis showed that the Total Plate Count was <10 CFU/g in the first week and increased to 625 CFU/g in the second week, remaining within the permissible limit (10^4 CFU/g). Total Yeast and Mould Count remained <10 CFU/g in both weeks, well within acceptable limits (10^2 CFU/g). These findings confirm that the product remained microbiologically safe for two weeks under room temperature storage.

Overall results indicate that the developed Nutribar is nutrient-dense, providing significant amounts of energy, protein, carbohydrates, fibre, iron, fats, and antioxidants such as vitamin C, contributing approximately one-fourth of daily nutrient requirements. Sensory evaluation and ANOVA analysis revealed significant differences only in texture and colour, while appearance, taste, aroma, and overall acceptability remained statistically similar across variations, supporting the acceptability of the formulated product and validating the study hypothesis.

CONCLUSION

The study embarked on the use of high-waste ingredients that are highly ignored but have functional benefits and nutritional value. The study successfully developed and evaluated Nutribar through sensory evaluation, nutritional analysis and shelf-life testing. In conclusion, the balance of ingredients and nutritional content suggest that the developed Nutribar packed with functional ingredients can be recommended to be a nutrient rich snack that may meet ¼ th of the daily snack requirement rich in energy, protein, fibre, essential vitamins and minerals for all age groups as it

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can be easily prepared at home. To address the limitations of the study, few suggestions that can be considered are, include a wider range of participants for sensory evaluation including different age groups and backgrounds and to conduct longer term of shelf-life study to understand better storage conditions.

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